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U. S. DEPT. OF AGRICULTURE
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F O R E S T R E S E A R C H D I G E S T

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LAKE STATES FOREST EXPERIMENT STATION*

FOREST SERVICE U. S. DEPT. AGR.

SPRING OR FALL FOR PLANTING?

A recent experiment conducted cooperatively by the Station and the Superior National Forest demonstrates very clearly and conclusively the advantage of spring planting as contrasted with fall.

The experiment was planned with the idea of investigating primarily the differences between the survival of spring and fall planted stock. It was believed that other factors might have some effect on the differences between spring and fall planting, and the following conditions were studied in the same experiment:

1. Density of cover: open, moderate, and dense.
2. Soil texture: light, medium, and heavy.

The stock used was 2-0 red pine and the planting was done in eight different CCC camp work areas located on the Superior National Forest. The fall of 1935 and the spring of 1936 were the seasons selected for the tests. The conclusions presented here are based on survival counts made in the spring of 1937. Sixty plots were available for the analysis.

Table 1 shows the average survival by planting season and soil texture classes. The very considerable difference in survival for spring and fall for the average of all soil conditions is obvious.

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*Maintained in cooperation with the University of Minnesota at University Farm, St. Paul, Minnesota.

Table 1.--Survival by soil and season of planting

(Examination made in May, 1937; basis 60 plots)

Season	Soil			
	Light	Medium	Heavy	Average
	Survival in percent			
Spring	56	70	96	66
Fall	33	36	17	33
Average	44	53	57	49

Reference is made to table 2, where it will be seen that the differences due to planting season are highly significant, which merely means that the differences are so large and so consistent among all the similar plots of the experiment that they can scarcely have arisen through fluctuations due to sampling errors. The second point of interest in table 1 is the increase in survival from light to heavy soils in the spring plantings and the opposite trend in the fall plantings. It will be noticed that the advantage of spring planting over fall planting is least on light soil, only 23 percent; on medium soil, spring planting has increased its lead to 34 percent; on heavy soil, it shows the greatest gain, 79 percent.

Summary

The experiment demonstrates that for 2-0 red pine, survival in spring planted areas is much better than in fall planting on all soils. Also, survival in spring planted areas is better on the heavier soils, while for fall planting the reverse is true and the light and medium soils show better survival.

This test, of course, compares the results of only two planting seasons. But since the fall of 1935 was a better than

average season for planting, whereas the spring of 1936 was followed by a severe drought period, it is felt that equally large differences will usually be found between spring and fall plantings, other things being equal.

The possibility of increasing the survival of fall planted trees by protecting them with a mulch of leaves and grass was considered and tried out. The mulching did reduce losses from frost heaving but other causes of loss made up for this advantage and the survival of mulched and unmulched trees was practically equal.

As a result of this experiment, the recommendation is made that as large a part as possible of the planting should be done in spring, and that what fall planting is done will succeed best on light and medium soils.

For those interested in statistical technique, the following analysis is given.

In statistical terms the difference in the effect of season depending on the soil texture is termed the "interaction" of soil and planting season. Table 2 indicates that this interac-

Table 2.--Analysis of season, soil, and cover

Source of variation	Degrees of freedom	Mean square	F
Total	59	597	
Season of planting	1	16,302	**66.26
Soil texture	2	698	2.84
Cover density	2	944	* 3.84
Interactions			
Seasons vs. soil	2	1,951	
Seasons vs. cover	2	30	**79.30
Soils vs. cover	4	234	
Seasons x soils x cover	4	99	
Within classes (error)	42	246	

*Significant at 5% level.
**Significant at 1% level.

action is significant. This is not only interesting to the statistician but is of utmost practical usefulness to the planter. Some planting must always be done in the fall, even though it is established that spring planting will give considerably better results. But the significant interaction of planting season and soil indicates that by confining the fall planting to the lighter soils, there will be a minimum loss due to the fact that the trees are planted in the fall rather than in the spring.

GIRDLING PAYS DIVIDENDS

The results of an experiment begun thirty years ago have just recently been presented in a bulletin* from the Northeastern Forest Experiment Station. In 1905 three plots were laid out in a young spruce-hardwood stand in New Hampshire. In this type, the spruce forms an understory of reproduction. Usually, a large proportion of the overtopping hardwoods is composed of inferior species. The spruce is unable to compete successfully with its more vigorous and weedy neighbors unless silvicultural measures are taken to release it.

On one plot, 36 percent of the hardwood basal area was girdled, while on the second treated plot, 52 percent was girdled. The third plot was left intact as a check. A second girdling treatment was made in 1915. The treatments on both plots were more severe than those made in 1905. Sixty-two percent of the hardwood basal area was removed from the first plot and 93 percent from the second.

At the end of 30 years after the first treatment, the sound merchantable volumes of spruce on the three plots were as

*Westveld, Marinus, "Increasing Growth and Yield of Young Spruce Pulpwood Stands by Girdling Hardwoods." U. S. Dept. Agr. Cir. 431.

indicated in the following table.

Volume of sound, merchantable Red Spruce
Cords per acre in 1935

Check plot	.45
Moderately girdled plot	4.90
Heavily girdled plot	11.40

If spruce pulpwood is figured at $2.50 per cord, the values of the pulpwood on the three plots are $1.12, $12.25, and $28.55. Total girdling costs were estimated at $2.00 per acre on the lightly cut plot and $2.60 on the more heavily treated area.

On the basis of current growth rates, the sound merchantable volumes have been conservatively estimated for 1945. They are 2 cords, 15.5 cords, and 24.8 cords for the check, lightly, and heavily cut plots, respectively.

From these figures, which are not "wishful guesses" but actual experience figures, it is apparent that girdling is a very worthwhile measure. The additional volume due directly and solely to girdling is approximately 13 cords on one plot and 23 cords on the other.

TREES BRING BENEFITS TO THE DANISH HEATH LANDS

The southwestern part of Jutland, which is a part of Denmark, was originally covered with forests, but reckless logging bared the land, exposing it to strong winds carrying considerable amounts of sand. A veritable desert was the result.

Records reveal that in the early eighteenth century the Slaug district, an area of some 90,000 acres, was the poorest and most desolate part of this region. The remarkable reclamation of this land is well described in "Hedeselskabets Tidsskrift" (The Journal of the Society for the Development of the Heath) published in Viborg, Denmark, June 15, 1936.

About 1866, plantations of trees were begun, but by 1900 the population was only about 10 inhabitants per square kilometer. Since that date great benefits from the plantation and shelterbelt plantings have been responsible for a vast change in the lives of the people living there. When trees were first planted, heather covered 65 percent of the land; in 1935, only 17.4 percent is occupied by this unproductive cover. The forest area of the once barren Slaug district has increased from 0 to 16.3 percent, a figure which is greater than the average for all of Jutland - 9 percent. In seventy years the Slaug district has been converted from a barren waste to a region of prosperous farms and woodlands.

As the forests grew, other conditions changed also. The population, which had been constantly dwindling up to 1860, began to increase. Table 1 shows the population trend.

Table 1.--Population

Year	1860	1901	1921	1930
Population	2,477	3,858	7,404	8,407

The record of the amount of livestock also reflects plainly the improvement in conditions. This data is presented in table 2. Sheep have decreased in number while other domestic

Table 2.--Livestock

	Year		
	1866	1898	1935
Horses	257	952	2,342
Cows	3,446	5,517	15,893
Sheep	9,319	6,187	894
Hogs	510	1,861	11,604

animals show great increases; this indicates a change from a low-grade range country to an area of rather intensive farming. Other districts in the heath lands have developed in the same degree as the Slaug, for which data has been presented.

The tree plantations have furnished substantial quantities of wood and have also been of great benefit to crop production. A three-year experiment shows very plainly the effect of shelter on an apple orchard. In this case the shelterbelt consisted of broadleaved trees about 6 meters high. At a distance of 10 meters from the windbreak, the average yield was 8,672 kilograms of apples per hectar; at 19 meters the yield was 4,433 kilograms; at 28 meters, 1,899 kilograms; decreasing steadily until at 46 meters the yield was only 1,254 kilograms.

Another experiment with strawberries shows a benefit due not only to increase in yield but also to hastening the time of maturity of part of the crop. The total yield for the season was 65 percent greater at a distance of 5-10 meters from the windbreak than at 25-30 meters, but the yield for the first ten days of picking was 2½ times as great close to the trees as at the further distance. As the early berries command the best price, this represents quite a monetary advantage.

Figure 1 indicates that shelterbelts have other values for human welfare and comfort than mere crop increases. Each of the four sections of the drawing represents a different district; the height of the tree is proportional to the amount of shelterbelt in the district, and the ease of walking indicates the protection afforded.

The Heath Society which is responsible for the tree planting has also instituted other developments which are partially responsible for the improvement of the heath lands. Among these

HOW THE WINDS ARE HUSHED
(DENMARK)
1.0 MILE OF SHELTERBELTS TO 1 SQ. MILE OF AREA
THE WIND IS STRONG BE SURE OF THAT
IT BENT MY BACK AND SNATCHED MY HAT
1.5 MILES OF SHELTERBELTS TO 1 SQ. MILE OF AREA
A LITTLE SHELTER HERE IS FOUND
STILL MERRILY THE WINDS GO ROUND
3.0 MILES OF SHELTERBELTS TO 1 SQ. MILE OF AREA
THE WINDS CALMED DOWN TO JUST A BREEZE
MAKES WALKING GOOD THANKS TO THE TREES
5.0 MILES OF SHELTERBELTS TO 1 SQ. MILE OF AREA
IS WHAT THIS GENTLEMAN WILL TELL

Figure 1

are marling and liming of the soil, manuring, watering by irrigation, and stream regulation. But these measures are all dependent upon the protection afforded by the shelterbelts, without which it was impossible to make even a beginning at reclamation.

If shelterbelts and tree plantations can be of such great value to a naturally humid region, they should be of much greater usefulness in our own arid plains country.

A NEW FIRE DANGER METER FOR THE LAKE STATES

A fire danger meter has recently been devised by the Lake States Forest Experiment Station for the use of forest officers in the Lake States. It consists of a pocket size, windowed envelope with two movable slides which can be set to show for any probable combination of conditions the average fire danger prevailing. The factors on which it is based are: amount of precipitation, days since rain, season of the year, relative humidity, wind velocity and visibility. For convenience in averaging danger ratings the various degrees of danger recognized are numbered from one to seven inclusive: 1 being used to designate "No Danger" and 7 "Extreme Danger."

The purpose of the meter is to furnish a comparable index of fire danger prevailing from day to day and place to place as a guide to administrative action. Since fire danger also depends on the character and amount of the forest fire fuels present and on the type and density of the forest cover, however, local conditions must be taken into account in translating the meter readings into terms of action called for. The meter in question was designed to apply specifically to Lake States conditions where light fuels and open or second growth stands predominate. Consideration is given, however, to the fact that fire danger increases as swamps and timbered areas dry out as the result of prolonged drought.

The meter is offered as a guide only and is not intended to relieve forest officers from the responsibility of exercising

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their own best judgment as to the degree of danger prevailing or the action called for to meet it. It is believed, however, that it will be found indicative of conditions in general and helpful in sizing up the situation locally. During the present season it is being tried out extensively throughout Region 9 to determine its applicability to local conditions and the extent to which it can be depended on in planning protective efforts.

THREE PROFITS FROM IMPROVEMENT CUTTINGS

During the past few years, it has been possible to do a great deal of stand improvement work which formerly was neglected because of the lack of labor. However, the results of some stand improvement work done on the Pike Bay Experimental Forest indicate that it is possible to get some of this type of work done without the use of the CCC or other sources of emergency labor.

On the Pike Bay Experimental Forest at Cass Lake, the Station has found that it is easy to interest local men in buying and cutting the material which should be removed in stand improvement work. These are chiefly men who are unemployed, at least during a part of the year. These men are willing to pay stumpage rates of $1.25 per thousand for aspen bolts and 25 cents a cord for fuel wood to a six-inch top. Only the minimum standard Forest Service stumpage rates are charged since the material cut is only the inferior stuff which is normally removed in an improvement cutting. The men are required to utilize all material down to a three-inch top, but they are not charged for any material smaller than a six-inch top. Working on this basis, the men usually pay stumpage in advance for 8 cords of fuel wood and 1000 board feet of bolts, which is the amount of material usually marked for removal from one acre. The laborers have been able to

sell the bolts for $12 a thousand at the mill, and the cordwood for $3.50. Thus the cash return to the worker is $54 less the $3.25 which he paid for stumpage, or a net return of $50.75. The men average about ten days to cut and transport this much material; thus they make a wage of around $5 per day.

Stand improvement work conducted in this manner is thrice blest: it improves the forest, it makes a cash return to the forest, and it gives gainful and morale-building employment.

Of course, there is probably a limit to the amount of work which can be done in this manner, as several factors such as proximity to towns and available markets are important. However, it is the forest stands which are readily accessible which need the most care and attention, and it should be possible to put these stands in good condition by using local labor. The efforts of the CCC and other emergency laborers could then be expended on the areas which are not suitable for the local workmen to handle.

SHELTERBELT EXPERIENCES IN CANADA

A farm owner in Saskatchewan recently wrote a letter to the ATLANTIC MONTHLY in which he sets forth his convictions regarding the value of shelterbelts in the western part of Canada and the United States. He cites results obtained at the Government nursery at Sutherland, Saskatchewan. There, 50 acres of oats were planted, 25 acres on the unprotected prairie and the remainder behind a low hedge of caragana. The oats in the open were blown out completely. The sheltered field yielded 45 bushels per acre. He also mentions the wind reduction effects observed at Indian Head, Saskatchewan, where a crop was protected for a distance of 750 feet from a 15-foot row of trees. Beyond this distance the crop was blown out entirely.

The most interesting part of this owner's letter, however, is his calculation of the amount of work involved in erecting a system of shelterbelts if the work were done by each farmer on his own land. He suggests that if every farmer should spend one day per year per quarter-section of land in planting shelterbelts, the whole of the Louisiana Purchase area could have protection within four years. The calculation is based on a man planting a half-mile per day, thus allowing for a belt of trees every 40 rods at the end of four years. Cultivation time is figured at 15 minutes per half-mile. Four cultivations per year would require, therefore, one hour per half-mile of planting per year. These calculations apply only to a single row of trees, and this owner plans either to reduce the spacing between belts to 20 rods or else plant more rows, when at the end of four years his present program is complete.

THE EFFECT OF FREEZING TEMPERATURE ON PLANTING STOCK

Bundles of planting stock are sometimes subjected to freezing temperatures when left in the field overnight during the spring and fall planting season. In an attempt to determine whether or not injury is sustained by coniferous seedlings under such conditions, freezing tests were conducted at the laboratory in St. Paul. Thirty bundles of 2-0 jack pine and white spruce, each containing 30 plants, were received from the Lydick nursery at Cass Lake, Minnesota. Five bundles of each species were subjected to a freezing temperature of +14° F. for periods of 18 hours, 1 day, and 3 days. Three corresponding groups of control plants were held in cold storage at +41° F. during the freezing treatments.

At the end of each treatment, i. e., 18 hours, 1 day, and 3 days at +14° F., five bundles of each species were removed from the freezing chamber and the cold storage room. The bundles of plants were soaked in cold tap water at 52° F. for one hour before heeling the plants in the greenhouse bed. At the end of three weeks the plants were lifted and examined for injury. The results are shown in the table.

JACK PINE

Degree of injury	18 hours		1 day		3 days	
	+14° F.	+41° F.	+14° F.	+41° F.	+14° F.	+41° F.
	%	%	%	%	%	%
Unaffected	100	100	100	100	100	100
Slightly injured*	0	0	0	0	0	0
Dead	0	0	0	0	0	0

WHITE SPRUCE

Unaffected	32	48	27	55	28	50
Slightly injured	19	16	20	17	30	9
Dead	49	36	53	28	42	41

*A small amount of injury usually confined to the fine, fibrous roots, which might possibly impair field survival.

Jack pine showed no injury from the treatments, and during the period of observation in the greenhouse an abundance of new growth appeared on roots and tops. White spruce showed a slight increase in injury with an increase in the time of exposure to freezing conditions, but this difference is probably not significant. New growth was observed on uninjured and several of the slightly injured spruce. It is interesting to note that the white spruce held in cold storage sustained almost as much injury as those receiving the freezing treatment.

It should be remembered that the exposure to freezing temperature was more severe and probably for a greater duration than that generally experienced in the field. The small bundles used were probably affected to a much greater degree than standard-sized bundles of planting stock, but this serves to emphasize the severity of the treatment to which the plants were exposed.

The results indicate that bundles of jack pine stock which may have been exposed to freezing temperatures in the field can be used for planting without fear of lose from the exposure. Even short periods of storage at temperatures both above and below freezing appear to be injurioue to white spruce.

"SAVE THE PIECES"

Recreation as a foreet use is beginning to turn from its role of neglected step-child to one of pampered darling. Until recently, a very small proportion of the Forest Service's efforts were devoted directly to the cause of the recreational user. Now, however, plans for developing the recreational values of the forest are receiving careful thought, and at this point a very timely article* by Robert Marshall of the Indian Service should be given consideration.

In this article Marshall puts up a stout defense for real wilderness areas. In fact, the article is more than a defense: it attacks vigorously the "road builders" and "unemployment relievers" who would apply their nostrums to the present wilderness areas. There are large numbers of people who prefer to take their vacations in truly primitive country, and they are willing to make whatever effort is necessary to reach and penetrate such

*Marshall, Robert, "The Universe of the Wilderness is Vanishing." Nature Magazine, April, 1937.

regions. A far larger number, of course, prefer to enjoy the "wilderness" from the comfort of the back seat of an automobile. The justification for much of the opening up of the wilderness areas has been the old battle cry, "The greatest good for the greatest number." Marshall shows very plainly that this policy should not necessarily be applied to every acre in the country. Tastes differ, and although the number of those who prefer to view the scenery from the rumble seat is probably vastly larger than the group which wants primitive areas, there is no reason why every possible acre should be made readily available to the majority. As Marshall demonstrates it, because more people prefer the movies than the opera is no reason for tearing down the opera house and building a movie palace. There is plenty of country for both types of recreationist and one must not be allowed to encroach on the other. Some real wilderness areas should be maintained in every section of the country for the use of those who prefer this type of area for their recreational activities. The problem of how much land should be devoted to each of the two groups merits very careful attention.

THE EFFECT OF WEEDING ON EARLY GROWTH OF JACK PINE

In May 1935, two plots at the Superior Branch were cleared of trees and brush and planted with two-year-old jack pine seedlings. In June 1935 and again in July of the same year, the weeds, suckers, and sprouts on part of each plot were removed. The balance on each plot was left unweeded. In June 1936 part of each weeded area was weeded again. Thus, at the end of two years, on each plot there were subdivisions that had never been weeded, weeded one year, and weeded two years.

In August 1936, it was very apparent that the trees in the completely weeded areas were in much better condition than those in the areas that had received less care. They were much more heavily branched, the needles were longer, and the stems were thicker. However, the average heights of the trees on the variously treated units were not significantly different except in two of the six possible cases. In examining small planted trees to determine growth, it is customary to measure only the height of the trees, but in this case it was evident that this measure was inadequate. The problem was to find a way to measure the differences. Weight would have been highly satisfactory but would have involved the destruction of the trees. The answer was found in measuring the diameters of the stems. The diameter measurements were taken at the ground line with a small caliper.

The table below shows the average heights and diameters on each of the units. In all six cases, the differences in average diameters are significant but the twice weeded unit in Plot B is the only one where the height differs significantly as a result of the treatment.

AVERAGE HEIGHT 1936

Treatment	Plot A	Plot B
	Feet	Feet
Not weeded	1.37 ± .038*	1.32 ± .031
Weeded one year	1.38 ± .036	1.32 ± .020
Weeded two years	1.45 ± .034	1.42 ± .027

AVERAGE DIAMETER AT BASE

	Inches	Inches
Not weeded	.231± .00621	.238± .00632
Weeded one year	.267± .00616	.308± .00513
Weeded two years	.324± .00700	.382± .00635

*Standard error.

It was estimated that the completely weeded trees weighed at least twice as much as the shaded ones.

The degree of weeding had a direct bearing also on survival. The table below indicates that on both plots, the trees weeded for two years showed remarkably low mortality. It should be pointed out, however, that these trees were planted during a favorable season - 1935 - and a similar experiment started in 1936 might have shown different results. Also, it is apparent that drought, rather than heat, was the limiting factor on the Superior during the past summer, and in this respect it differed somewhat from other places in Region 9 where trees exposed to full sunlight were frequently killed by the heat.

Survival of two-year-old jack pine after two years in field

Treatment	Survival	
	Plot A	Plot B
	Percent	Percent
Not weeded	79	76
Weeded one year	90	90
Weeded two years	93	98

Plot A was situated on good loam soil having a northerly exposure and Plot B on a very light, sandy soil on a southerly exposure. The results are remarkably consistent, considering the great differences in habitat. The experiment was based upon 1,457 trees divided about equally between the six samples.

This experiment, though only of short duration, points to the desirability of taking care of young plantations by the removal of the competing vegetation - a point which has only too often been neglected in the past.

RODENTS AND DIRECT SEEDING

It has been frequently observed by foresters that when conifer seeds are planted in artificially prepared spots, small animals eat many of the seeds before they have time to germinate. This has led to the belief that the losses are higher than occur in natural seeding, because the seed-eating creatures were attracted to the freshly disturbed ground and the unusual concentration of seeds. However, an experiment recently conducted by Shaler Aldous and R. K. LeBarron at the Superior Branch Station indicates that the seed-consuming animals have no greater difficulty in locating individual jack pine seeds placed upon undisturbed ground.

The experiment consisted of placing individual jack pine seeds upon an undisturbed ground surface of litter and needles. The seeds were spaced about one foot apart and each was carefully marked by placing two small sticks each four inches in a straight line from the seed. Four plots each containing four subplots were established: two in an uncut jack pine stand and two in a jack pine area clear cut in 1935. In each subplot 50 seeds were placed as described above. The experiment was conducted during late May and early June.

The plots were examined 18 days after the seeds had been placed. The table below shows the results of the examination.

Plot		Number seeds planted	Seeds missing or damaged	Seeds found		
No.	Location			Sound	Germinating	Empty
			%	%	%	%
1	Uncut stand	200	80	16	1	3
2	Clear cut area	*195	68	21	6	5
3	Uncut stand	200	66	22	5	7
4	Clear cut area	*189	74	19	2	5

*Two hundred seeds actually sown but a few spots were tramped by deer.

It is quite evident that the animals responsible for the seed disappearance had little difficulty in finding them. The presence of many mouse droppings on both plots throws suspicion on them.

The day after the examination 30 mouse traps were set and baited with oat meal on each plot. The following morning only one red-backed mouse was caught on the clear-cut plot. The second night the traps were baited with jack pine seeds and again one red-backed mouse was caught on the clear-out area. The third night nothing was caught. Either the traps were not working, the bait unattractive, or animals other than rodents were in part responsible for the missing seeds.

PLANTING IN THE DANISH HEATH*

The Danish heath land presents one of the most difficult planting sites in all of Europe. Successful planting requires a large expenditure for the preparation of the ground and in caring for the plantation. The average heath land is covered with a low, shrubby growth of Calluna which forms a mat-like growth approximately one foot in height. Ordinarily there is a layer of raw humus approximately 12 inches thick on which the heath is growing. Beneath this, the soil is rather coarse and is underlain by hardpan.

The soil is prepared by plowing the area 100 percent and allowing it to lie for one year, during which decomposition of the heather takes place. It is then thoroughly disked and is allowed to remain a second year. Following this the soil is plowed a third time, this time to a depth sufficient to break the hardpan. Ordinarily two plows are required, the second one running

*This is the sixth of a series of articles on European forestry practices by H. L. Shirley.

in the bottom of the furrow produced by the first. The hardpan must be allowed to weather and the soil to settle before planting. The entire preparation period requires from two to four years. During this time the soil is greatly improved through reduction of acidity and breaking up of the podsolized condition.

The trees are set in rows 4½ feet apart, and spaced approximately 4½ feet in the rows. The first planting is with mugho pine. This produces nothing except fuel wood and is merely preliminary to planting with Norway spruce, Sitka spruce, and Douglas fir, which are the principal crop trees. These are planted after the mugho pine has attained a height of some five feet, which prepares the planting site for the reception of other trees. The third step is to work in a mixture of hardwoods with the conifers after they have become well established.

Great care must be exercised in harvesting the final crop in order to reproduce it successfully. Where clear-cutting has been practiced, the soil has apparently gone back to the original heath condition. Planting on clear-cut areas has repeatedly met with failure. A wedge system of strip cutting, followed immediately by planting, appears to be a successful method of reproducing the forest. Partial cutting is impractical due to windthrow.